World Academy of Science, Engineering and Technology
International Journal of Agricultural and Biosystems Engineering
Vol:14, No:04, 2020

Introducing Global Navigation Satellite System Capabilities into IoT Field-Sensing Infrastructures for Advanced Precision Agriculture Services

Authors : Savvas Rogotis, Nikolaos Kalatzis, Stergios Dimou-Sakellariou, Nikolaos Marianos

Abstract : As precision holds the key for the introduction of distinct benefits in agriculture (e.g., energy savings, reduced labor costs, optimal application of inputs, improved products, and yields), it steadily becomes evident that new initiatives should focus on rendering Precision Agriculture (PA) more accessible to the average farmer. PA leverages on technologies such as the Internet of Things (IoT), earth observation, robotics and positioning systems (e.g., the Global Navigation Satellite System – GNSS - as well as individual positioning systems like GPS, Glonass, Galileo) that allow: from simple data georeferencing to optimal navigation of agricultural machinery to even more complex tasks like Variable Rate Applications. An identified customer pain point is that, from one hand, typical triangulation-based positioning systems are not accurate enough (with errors up to several meters), while on the other hand, high precision positioning systems reaching centimeter-level accuracy, are very costly (up to thousands of euros). Within this paper, a Ground-Based Augmentation System (GBAS) is introduced, that can be adapted to any existing IoT field-sensing station infrastructure. The latter should cover a minimum set of requirements, and in particular, each station should operate as a fixed, obstruction-free towards the sky, energy supplying unit. Station augmentation will allow them to function in pairs with GNSS rovers following the differential GNSS base-rover paradigm. This constitutes a key innovation element for the proposed solution that encompasses differential GNSS capabilities into an IoT field-sensing infrastructure. Integrating this kind of information supports the provision of several additional PA beneficial services such as spatial mapping, route planning, and automatic field navigation of unmanned vehicles (UVs). Right at the heart of the designed system, there is a high-end GNSS toolkit with base-rover variants and Real-Time Kinematic (RTK) capabilities. The GNSS toolkit had to tackle all availability, performance, interfacing, and energy-related challenges that are faced for a real-time, low-power, and reliable in the field operation. Specifically, in terms of performance, preliminary findings exhibit a high rover positioning precision that can even reach less than 10-centimeters. As this precision is propagated to the full dataset collection, it enables tractors, UVs, Android-powered devices, and measuring units to deal with challenging real-world scenarios. The system is validated with the help of Gaiatrons, a mature network of agro-climatic telemetry stations with presence all over Greece and beyond (> 60.000ha of agricultural land covered) that constitutes part of “gaiasense” (www.gaiasense.gr) smart farming (SF) solution. Gaiatrons constantly monitor atmospheric and soil parameters, thus, providing exact fit to operational requirements asked from modern SF infrastructures. Gaiatrons are ultra-low-cost, compact, and energy-autonomous stations with a modular design that enables the integration of advanced GNSS base station capabilities on top of them. A set of demanding pilot demonstrations has been initiated in Stimagka, Greece, an area with a diverse geomorphological landscape where grape cultivation is particularly popular. Pilot demonstrations are in the course of validating the preliminary system findings in its intended environment, tackle all technical challenges, and effectively highlight the added-value offered by the system in action.

Keywords : GNSS, GBAS, precision agriculture, RTK, smart farming
Conference Title : ICAS 2020 : International Conference on Agricultural Systems
Conference Location : Athens, Greece
Conference Dates : April 09-10, 2020